Spring 3-8-2021

Isometric Exercises and Stretching Warm-Up Program for University String Musicians: An Intervention Study

Emma Porter
University of Nebraska - Lincoln

Isometric Exercises and Stretching Warm-Up Program for University String Musicians: An Intervention Study

An Undergraduate Honors Thesis
Submitted in Partial fulfillment of
University Honors Program Requirements
University of Nebraska Lincoln

By
Emma Porter
Bachelor of Arts- Music (Viola Performance)
Glenn Korff School of Music
Bachelor of Science- Nutrition Science
College of Education and Human Sciences

March 8, 2021

Faculty Mentors:
Professor Clark Potter, MM, MFA, Music-Strings Department
Dr. Shinya Takahashi, Ph.D., Nutrition and Health Department

Abstract

The purpose of this investigation was to find the effects of reducing pain through combining isometric and stretching warm-up exercises for stringed instrument musicians. In Lee's et al. (2013) study, it showed that about 75 % of musicians have work-related musculoskeletal disorders and experience pain because of playing. In this study, they also saw that string players have the highest prevalence of both musculoskeletal disorders and pain while playing (Lee et al., 2013). In Nawrocka's et al. (2014) journal article, the study showed the correlation of more pain in musicians that did not meet the recommended criteria for physical activity. This information shows that musicians experience pain, and physical activity may be a solution to decreasing the pain the musicians experience during playing their instrument. For the current investigation, an 8-week isometric exercise and stretching program was given to participants as a warm up program before playing their stringed instrument. A total of 19 participants were randomly assigned to an experimental group (10 participants) and a control group (9 participants). The experimental group participated in the exercise and stretching warmup program. The control group did not participate in the program, but was used to isolate the effect of the independent variable. They both took pre and post exercise intervention questionnaires to determine information such as age, sex, dominant hand, the instrument they played, music group participation, how much they practiced, their practicing habits for consistent practicing, physical activity level, and anywhere they have felt pain caused by practicing their instrument. This showed any changes the participants had made when participating in the exercise program.

Based on the results of the exercise program, the participants in the experimental group showed a statistically significant decrease ($P=0.05$) in head and neck pain in self practice and

back pain in large ensemble practice. Other areas like back and hand pain in the self-practice, and head, neck, and shoulder pain in large ensemble practice showed positive trends of decrease in pain within the experimental group compared to the control group. Overall, isometric and stretching exercises in the intervention program were found to reduce pain in different areas such as the head and neck area in self practice and back pain in large ensembles for string musicians. It is advisable to implement these stretches and exercises not only to decrease discomfort and pain, but also to improve their performances.

Key Words: isometric exercises, university string players, warmup exercises, pain, stretching exercises, musicians

Isometric Exercises and Stretching Warm-Up Program for University String Musicians: An Intervention Study

Introduction

Musicians have been struggling with Performance Related Musculoskeletal Disorders (PRMDs), pain, or both due to the result of playing their musical instrument for prolonged trainings. Some recent studies showed that 63% to 97% of professional musicians have been affected by PRMDs during their careers (Lundborg et al., 2018). The playing-related disorders have increased through the years in the music industry and occupational medicine has also increased their research on the occupational overuse syndrome (Lee et al., 2013). There have been various studies focusing on professional musicians with regards to their pain or their PRMDs while playing. However, not many studies have focused on university level musicians, let alone string players. String players are shown to have the highest prevalence of both musculoskeletal disorders and pain while playing (Lee et al., 2013). This is probably due to the risk factors of biomechanical and psychosocial such as highly repetitive movements, precision work, static work, awkward positions, high mental demands, and low decision latitude (Lundborg et al., 2018).

Exercise intervention has been shown to decrease musicians pain levels and their PRMDs (Nawrocka et al., 2014). Various types of exercise programs have been studied with regards to decreasing musicians' pain such has strengthening exercises, core exercises, Tuina exercises, posture awareness, and stretching (Ajidahun, 2013; Ajidahun et al., 2017; Sousa et al., 2015; Wilke et al., 2011). However, no studies have been shown with musicians participating in an exercise program with isometric exercises and stretching. There was a study containing 30 female sewing machine operators that completed an isometric exercise program that showed to

improve pain and percentage disability, suggesting that this may be helpful for other types of work, like playing an instrument (Tariq et al., 2017). Therefore, the aim of the study is to determine if an isometric exercise and stretching warm up program is suitable for string musicians at the university level to beneficially change pain levels while they are playing their instruments.

Review of Literature

Stretching Exercise

There have been research studies that have focused on a stretching exercise program for musicians and have seen positive results. In Ajidajun's (2019) study, stretching was an intervention that had been examined. In his review, muscle stretching had been "hypothesized to increase muscle compliance, which results in extensibility of the muscle that leads to a reduction in muscle force" (Ajidajun, 2019, pp. 23). In other words, with the result of stretching, the muscles that are used in activities are able to perform at longer time and reduce the work needed to do the activity. Ajidajun also reviewed that "stretching of the shoulder and forearms muscles during breaks during music practices significantly reduced discomfort and perceived exertion among string players" (Ajidajun, 2019, pp. 23). This information could suggest that stretching exercises could reduce pain from their orchestral activity and also reduce the amount of work the muscles are exerting in the string players when they are playing their instruments.

Isometric Exercises

Another article looked at the effects of isometric exercises for decreasing neck pain. This study was not looking at musicians but female sewing machine operators. In Tariq et al.'s (2017) study, Tariq compared the efficacy of isometric exercises and active range of motion in neck pain of these women. With the work of the Northwich Park Neck Pain Questionnaire, the study showed that although both types of exercises reduced the female sewing machine operators' neck pain, the isometric exercises were more effective (Tariq et al., 2017). Although the sewing machine operators are a different study than musicians, they are similar in the way of repetitive motion which can result in possible pain of certain parts of the body and musculoskeletal disorders.

Warmup Program

This exercise intervention study for musicians also specializes in the fact that it is a warm up program, rather than a regular exercise program or a cool down program. There have been some studies that have shown a positive outcome because of warm up programs (Ajidahun, 2013; Chan et al., 2013; Foxman et al., 2006). For example, "in sports, especially football, standard warm up exercise program has been found to be beneficial in the reduction of musculoskeletal disorders" (Ajidahun, 2013, p. 2069). In other words, if warm up programs work well for sports, it may also be beneficial for musicians that are experiencing musculoskeletal disorders or pain when playing. Foxman and Burgel's (2006) study have also shown that the warm up exercises increase heart rate and circulation, increase blood flow which can help nourish the nerves and soft tissues, stretch the nerves and soft tissues, and also allow the smooth nerve gliding to occur; all this may help the body grow accustomed to the body's next activities to come, like practicing an instrument.

With all of these background studies of warmup exercises, isometric exercises, and stretching programs, all with beneficial outcomes, it may be a logical step to introduce these all into a study. With the warmup isometric and stretching exercises all together, it may help decrease the pain musicians are experiencing.

Methodology

Subject

There was a total of 19 participants in the experiment group and the control group. These subjects were University of Nebraska Lincoln students that either majored or minored in music and were working for an undergraduate or graduate degree. The students had to fit the exclusion/inclusion criteria of a minimum age requirement of 19 years old, play a stringed instrument (violin, viola, cello, or bass), and who are not experiencing musculoskeletal injuries diagnosed by a physician. These participants also took a PAR-Q and You Survey which identified potential risks for the participants in the study to notify them of problems during physical activity (See Appendix A). The participants were recruited by an informational email about the study to all of the stringed musicians at University of Nebraska Lincoln. If the possible participants did not meet the criteria for the study, they were able to get the exercise directions if they wanted to try out the exercise program on their own.

Table I. Demographic Characteristics of Participants

Variable (N= 19)	Overall
Age (Average years of age)	21
Gender	
Male	9 (47%)
Female	10 (53%)
Dominant Hand	
Left	3 (16%)
Right	16 (84%)
String Instrument, n (%)	
Violin	5 (26%)
Viola	7 (37%)
Cello	5 (26%)
Bass	2 (11%)
Major or Minor in Music	
Major	16 (84%)
Minor	3 (16%)
Undergraduate or Graduate Student	
Undergraduate	16 (84%)

Graduate	3 (16%)
Involved in Music Groups	
Self-Practice only	0 (0%)
Self-Practice and Small Ensemble	0 (0%)
Self-Practice and Large Ensemble	9 (47%)
Small Ensemble and Large Ensemble	0 (0%)
Small Ensemble only	0 (0%)
Large Ensemble only	1 (6%)
Self-Practice, Small Ensemble, and Large Ensemble	9 (47%)
Playing Experience	
9-12 years	12 (63%)
13-16 years	5 (26%)
17+ years	2 (11%)
Amount of Exercise (days per week)	
0 days	2 (11%)
1-2 days	6 (31.5%)
3-4 days	6 (31.5%)
5+ days	5 (26%)
Amount of Practicing instrument (hours per week)—Self practice and Rehearsing with ensembles	
0 hours	0 (0%)
1-5 hours	1 (6%)
6-10 hours	3 (16%)
11-15 hours	3 (16%)
16-20 hours	6 (31.5%)
21-25 hours	5 (26%)
26-30 hours	0 (0%)
30+ hours	1 (6%)

Instrumentation

A Pre-exercise intervention questionnaire and a Post-exercise intervention were the instruments used for this study (See Appendices C and D). The questionnaires were to determine information such as age, sex, dominant hand, the instrument they played, music group participation, how much they practiced, their practicing habits for consistent practicing, physical activity level, and anywhere they had felt pain caused by practicing their instrument. A Numeric Pain Rating Scale was used to measure the participants pain with regards to head/neck,

hands/wrists, shoulders, back, elbows, and lower extremities (hips, legs and ankles). These pain scales were then grouped into three groups: pain experienced during self-practice, small group ensemble, and large group ensemble. The participants self-indicated which areas they felt pain for each group, and if they did not participate in the group, they left the section blank.

Procedure

There were two groups of participants for this study—one control group and one experimental group, both randomly selected. The control group had 9 participants that met the criteria of the study; the experimental group consisted of 10 participants. The students in the experimental group participated in the 8-week isometric exercise warmup program. Both the control and the experimental groups completed the pre-exercise intervention questionnaire and the post-exercise intervention questionnaire before and after the 8 weeks. As the experimental group took part in the exercise program, the control group carried on their normal instrument practice and exercising routines.

Prior to participating in the study, the researchers and the prospective participants had three online Zoom visits (for COVID-19 safety reasons) total throughout the study. The first visit consisted of both groups where participants were asked to complete the pre-questionnaire and the PAR-Q and You survey. After this visit, the possible participants were identified based on the exclusion/inclusion criteria, and then randomly assigned to either the control group or the experimental group. The next visit was right before the beginning of the 8-week program. This visit consisted only of the experimental group. This visit consisted of looking over the different exercises and stretches for the warm-up program and for the participants to ask any questions they had about the program. This is when the researchers gave all the instructions for the exercises along with access to the logbook (See Appendix B). This logbook was for the

participants to keep track of the completion of the exercises each week. The logbook also helped the researchers to show how completion would affect the results; the participants had to complete 80% of the days of the exercise program in order for their information to be included in the analyses. The final visit was for both the experimental group and the control group. This meeting was for the completion of the post-exercise intervention questionnaire and for the experimental group to turn in their logbook of the exercises they completed.

The exercise program consisted of two different sections-- isometric exercises and stretches. The stretches and exercises focused on upper body including neck, wrists, chests, triceps, upper and lower back, biceps, forearms, abs, and hand muscles. These stretches and exercises program were based on guidelines and exercises through the ACSM's Guidelines for Exercise Testing and Prescription, OSHA exercise guidelines, and HEP2go.com—a website for rehabilitation specialists (Alaska, 2015; HEP, 2021; Riebe, 2018). This exercise program lasted 8 weeks, and the exercises consisted of twice a week periods (Tuesday and Thursday) for 20 minutes as a warmup for self-practice time. These exercises were done individually by each participant during these days. The isometric exercises and stretches were done by the instructions on Table II (see below), and also examples were given during the Zoom visits. The instructions of the exercises were to do them in the order of Table II, and to take rest time if overexerted. The stretches stayed the same for all 8 weeks; however, the isometric exercises increased in intensity. For the first four weeks, the participants did the isometric exercises for two sets, and the last four weeks, the participants did the exercises for three sets.

Table II. Stretches and Exercises

Wrist flexion and Extension Stretch	Without bending the elbow, extend one arm outwards. Bending the wrist upwards, use the other hand to pull the fingers back towards you. Hold for 10 seconds. Release and bend the same wrist downwards, gently pulling on the fingers. Hold for 10 seconds. Repeat for the other hand.
Neck Stretch (Down, L and R side)	DOWN- While sitting the head forward, gently lower chin towards chest. Place your hand on the back of your head for added stretch. Do this for 20 seconds. L and R- Tilt head towards shoulder without twisting the neck. You should. Feel the neck pull on the opposite side. The this once for 20 seconds. Repeat for the other side.
Triceps Stretch Behind Head	Stand with right arm up and behind head, reaching down the back as far as comfortable. Use free hand to press elbow backwards stretching the triceps muscle. Hold for 10 seconds. Repeat with left arm.
Chest Opening Stretch- Corner Stretch	Stand in corner, hands about shoulder level. Lean forward until comfortable stretch felt across chest. Hold 20 seconds.
Lower Back Stretch	Standing with feet shoulder width apart, twist while leaning forward to touch your toe with the opposite hand. Extend your other arm up behind you. Hold for 10 seconds. Repeat with the other hand.
Wrist Circles	For both hands: with fingers curled, bending at your wrist, move slowly in clockwise circles. Do this for 10 secs. Repeat in counterclockwise direction for 10 seconds.
Arm Circles	Bring arms out to the side, rotating at the shoulder, do 10 seconds going clockwise and 10 seconds going counterclockwise.
Squats (support with chair)	Place a chair behind you for safety. While standing with feet shoulder width apart, bend your knees and lower your body towards the floor. Your body weight should mostly be directed through the heels of your feet. Gently touch the chair with your bottom, then return to a standing position. Knees should bend in line with the 2nd toe and not pass the front of the foot. Repeat 10 times.
Forearm Flexion	Keep your forearm steady in a palm down position. Use the opposite hand to push against an upward movement of your hand at the wrist. Repeat with other arm.
Bicep Curl Against Table	Gently pull your hand up against a table or level surface with your elbow partially bent. Repeat with other arm.
Triceps Extension Against Table	Gently push your hand down against a table or level surface with your elbow bent at a 90 degree angle. Repeat with other arm.

Shoulder Abduction	Stand with your body slightly away from your body with back of the hand against the wall. Press your hand into the wall to activate your shoulder. Press as hard as you can tolerate. Repeat with the other side.
Prayer Exercise	Place palms together and push them against each other to activate your chest. Press as hard as you can tolerate.
Lat Pulldown	Stand with palm of left/right hand at wall. Gently push palm into wall, pulling shoulder blade down and in. Repeat with the other side.
Plank (30 seconds, 1 set)	While lying down, lift your body up on your elbows and toes. Try and maintain a straight spine. Do not allow your hips or pelvis on either side to drop. Maintain pelvic neutral position the whole time.
Hand Grip Contraction	Place a rolled-up cloth /towel/jacket in your hand and squeeze repeatedly. Repeat with other hand.
Hand Intrinsic Push Exercise	Push fingers of bottom hand onto top hand. Repeat with other hand on the bottom position.

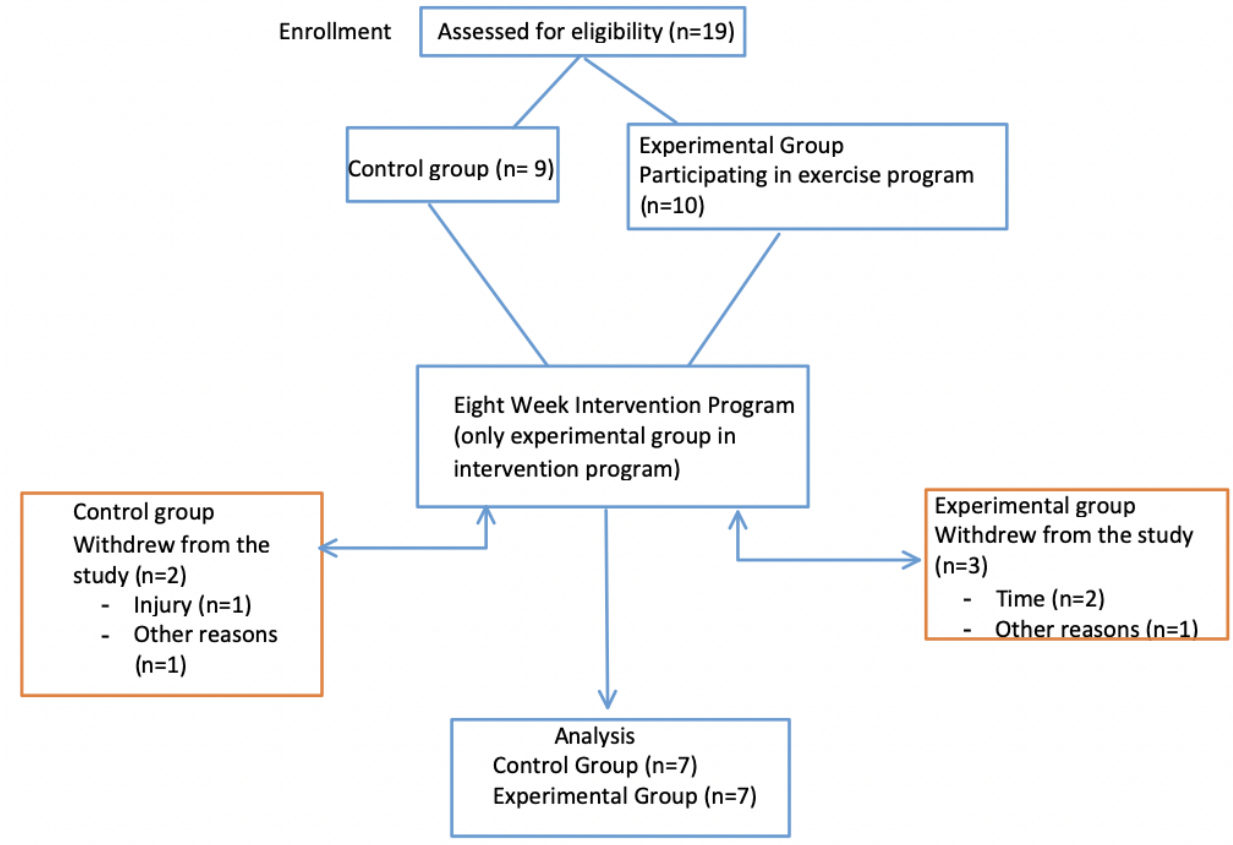


Figure 1. Recruitment Flow Chart

Results

Quantitative Results

Change scores of the control and experimental group were based on the post and pre-exercise intervention questionnaire, shown in Table III; a negative change score determined a decrease in pain, whereas a positive change score determined an increase. To examine statistical significance, the alpha value used was p-value= 0.05. The change score in terms of the experimental group mean was statistically significant with relation to pain experienced in the head/neck area during self-practice (p=0.045). The change score in terms of the experimental group mean was also statistically significant with relation to pain experienced in the back area during large ensemble practice (p=0.017). Some other change scores were not statistically significant, but showed positive trends with a decrease in pain for the experimental group. These include the back and hand pain in the self-practice, and head, neck, and shoulder pain in large ensemble practice. Although these showed positive trends, they were not statistically significant potentially due to the small sample size.

The study also compared females and males of both groups before the experimental study to see which sex experienced more pain, shown in Table 5. Although none of them deemed to be statistically significant, females showed a positive trend of more shoulder pain in the large ensemble practice (P= 0.098).

Another comparison was made between the different string instruments musicians (bass, cello, viola, and bass) that experienced more pain before the experimental study, shown in Table 4. In the comparison, cellists and violists experienced significantly more hand pain in a small ensemble practice (P= .042). Violists showed a positive trend of more head and neck pain in self-practice, and shoulder pain in small and large ensemble practice (P= 0.146; P= 0.185; P= 0.112).

Table III. T- Test: Change Scores of Post and Pre-Questionnaire with Experimental and Control group

Areas of Pain in Various Playing Settings	Mean Value	Standard Deviation Value	T Test Value	P value
Head and Neck Pain-Self Practice	Experimental: - .90 Control: .44	Experimental: 1.101 Control: 1.590	-2.163	0.045*
Shoulder Pain- Self Practice	Experimental: -.2857 Control: -.8571	Experimental: .95119 Control: -1.67616	0.784	0.448
Back Pain-Self Practice	Experimental: -1.5714 Control: .4286	Experimental: 1.51186 Control: 2.69921	-1.71	0.113
Elbow Pain-Self Practice	Experimental: .1429 Control: -.1429	Experimental: 1.21499 Control: .37796	0.594	0.563
Hand Pain-Self Practice	Experimental: -1.2857 Control: -.1429	Experimental: 1.60357 Control: .69007	-1.732	0.109
Lower Extremities Pain- Self Practice	Experimental: -.1429 Control: -.1429	Experimental: .69007 Control: .37796	0	1
Head and Neck Pain-Small Group Practice	Experimental: .5000 Control: 2.000	Experimental: 2.12132 Control: 2.0000	-0.805	0.48
Shoulder Pain- Small Group Practice	Experimental: 1.0000 Control: -.3333	Experimental: 2.82843 Control: .57735	0.859	0.453
Back Pain- Small Group Practice	Experimental: .0000 Control: 1.0000	Experimental: 1.41421 Control: 1.73205	-0.671	0.55
Elbow Pain- Small Group Practice	Experimental: -2.0000 Control: .0000	Experimental: 2.82843 Control: .0000	-1.342	0.272
Head and Neck Pain- Large Group Practice	Experimental: -1.000 Control: .8750	Experimental: 1.15470 Control: 2.58775	-1.763	0.101
Shoulder Pain- Large Group Practice	Experimental: -1.1429 Control: .8750	Experimental: 1.46385 Control: 2.58775	-1.914	0.078
Back Pain- Large Group Practice	Experimental: - 1.571 Control: .5000	Experimental: 1.51186 Control: 1.41421	-2.741	0.017*
Elbow Pain- Large Group Practice	Experimental: -.2857 Control: .1250	Experimental: -.75593 Control: .35355	-1.379	0.191
Hand Pain- Large Group Practice	Experimental: -.7143 Control: .0000	Experimental: .95119 Control: .92582	-1.472	0.165
Lower Extremities Pain- Large Group Practice	Experimental: -.2857 Control: .2500	Experimental: .75593 Control: .70711	-1.418	0.18

*=Number referenced in results section.

Table IV: ANOVA Test: Pain Experienced Before Program Comparing String Instruments

Area of Pain Prior to Program	Instrument	N	Mean Value	Sum of Squares	P Value
	Bass	1	0	Between Groups:	0.146*
Head and Neck Pain-Self Practice	Cello	4	0.5	21.857	
	Viola	6	3.17	Within Groups	
	Violin	3	1.33	32.5	
	Bass	1	0	Between Groups:	0.193
Shoulder Pain- Self Practice	Cello	4	1.25	22.107	
	Viola	6	3.67	Within Groups	
	Violin	3	1.67	38.75	
	Bass	1	1	Between Groups:	0.355
Back Pain-Self Practice	Cello	4	0.5	29.024	
	Viola	6	3.83	Within Groups	
	Violin	3	2	79.833	
	Bass	1	0	Between Groups:	0.587
Elbow Pain-Self Practice	Cello	4	0	1.214	
	Viola	6	0.67	Within Groups	
	Violin	3	0.33	6	
	Bass	1	4	Between Groups:	0.233
	Cello	4	2	21.214	
Hand Pain-Self Practice	Viola	6	3.33	Within Groups	
	Violin	3	0.33	42	
	Bass	1	0	Between Groups:	0.687
Lower Extremities Pain-Self Practice	Cello	4	0.25	1.25	
	Viola	6	0.83	Within Groups	
	Violin	3	0.33	8.25	
	Bass	0	-	Between Groups:	0.444
Head and Neck Pain-Small Group Practice	Cello	2	2	4	
	Viola	2	1	Within Groups	
	Violin	3	1	8	
	Bass	0	-	Between Groups:	0.185*
Shoulder Pain- Small Group Practice	Cello	2	0	6.833	
	Viola	2	2.5	Within Groups	
	Violin	3	0.67	5.167	
	Bass	0	-	Between Groups:	0.9
Back Pain- Small Group Practice	Cello	2	2	1.214	
	Viola	2	2.5	Within Groups	
	Violin	3	3	22.5	
	Bass	0	-	Between Groups:	0.112*
Elbow Pain- Small Group Practice	Cello	2	0	8.929	
	Viola	2	2.5	Within Groups	
	Violin	3	0	4.5	
	Bass	0	-	Between Groups:	0.042*
Hand Pain- Small Group Practice	Cello	2	1.5	3.857	
	Viola	2	1.5	Within Groups	
	Violin	3	0	1	
	Bass	0	-	Between Groups:	0
Lower Extremities Pain-Small Group Practice	Cello	2	0	0	
	Viola	2	0	Within Groups	
	Violin	3	0	0	
	Bass	1	0	Between Groups:	0.358
Head and Neck Pain-Large Group Practice	Cello	4	0.75	13.136	
	Viola	7	2.57	Within Groups	
	Violin	4	1	40.464	
	Bass	1	0	Between Groups:	0.112
Shoulder Pain- Large Group Practice	Cello	4	1.25	34.888	
	Viola	7	3.71	Within Groups	
	Violin	4	0.33	50.845	
	Bass	1	1	Between Groups:	0.45
Back Pain- Large Group Practice	Cello	4	1.25	15.136	
	Viola	7	3.43	Within Groups	
	Violin	4	3	58.464	
	Bass	1	0	Between Groups:	0.492
Elbow Pain- Large Group Practice	Cello	4	0	4.876	
	Viola	7	1.14	Within Groups	
	Violin	4	0	20.857	
	Bass	1	4	Between Groups:	0.21
Hand Pain- Large Group Practice	Cello	4	1.5	20.505	
	Viola	7	2.71	Within Groups	
	Violin	4	0	42.429	
	Bass	1	0	Between Groups:	0.798
Lower Extremities Pain-Large Group Practice	Cello	4	0.5	0.619	
	Viola	7	0.43	Within Groups	
	Violin	4	0	6.714	

*=Number referenced in results section.

Table V: T- Test: Comparing Female and Male Participants Pain Scales Before Intervention

Area of Pain Prior to Program	Mean Value	Standard Deviation Value	T Test Value	P value
Head and Neck Pain-Self Practice	Female: 2.00 Male: 1.50	Female: 2.138 Male: 2.074	0.438	0.669
Shoulder Pain- Self Practice	Female: 2.63 Male: 1.83	Female: 2.446 Male: 1.835	0.663	0.52
Back Pain-Self Practice	Female: 2.13 Male: 2.50	Female: 3.137 Male: 2.8111	-0.231	0.821
Elbow Pain-Self Practice	Female: .38 Male: .33	Female: .744 Male: .816	0.1	0.922
Hand Pain-Self Practice	Female: 3.00 Male: 1.50	Female: 2.507 Male: 1.517	1.291	0.221
Lower Extremities Pain- Self Practice	Female: .63 Male: .33	Female: 1.061 Male: .516	0.617	0.549
Head and Neck Pain-Small Group Practice	Female: 1.00 Male: 1.00	Female: 1.732 Male: 1.414	0	1
Shoulder Pain- Small Group Practice	Female: 1.33 Male: .75	Female: 2.309 Male: .500	0.505	0.635
Back Pain- Small Group Practice	Female: 2.00 Male: 3.00	Female: 2.000 Male: 2.160	-0.624	0.56
Elbow Pain- Small Group Practice	Female: 1.33 Male: .25	Female: 2.309 Male: .500	0.939	0.391
Head and Neck Pain- Large Group Practice	Female: 2.00 Male: 1.14	Female: 2.330 Male: 1.464	0.837	0.418
Shoulder Pain- Large Group Practice	Female: 3.13 Male: 1.00	Female: 2.642 Male: 1.826	1.784	0.098*
Back Pain- Large Group Practice	Female: 2.63 Male: 2.57	Female: 2.722 Male: 1.902	0.044	0.966
Elbow Pain- Large Group Practice	Female: .25 Male: .86	Female: .707 Male: 1.864	-0.857	0.407
Hand Pain- Large Group Practice	Female: 1.75 Male: 2.14	Female: 1.832 Male: 2.545	-0.347	0.734
Lower Extremities Pain- Large Group Practice	Female: .50 Male: .14	Female: .926 Male: .378	0.95	0.359

*=Number referenced in results section.

Discussion

College stringed instrument musicians in the warmup isometric exercise and stretching program reported of a significant decrease in pain in specific areas during various practice settings compared to the control group. Although there was only a significant decrease in pain in head and neck pain in self practicing and back pain in large ensemble practice, there were positive trends of decrease in pain in other areas. However, due to the potential problem of the small sample size, these areas of pain did not show to be statistically significant. The participants overall said that the "stretches helped when there was discomfort" and "helped loosen them up". Other studies also showed self-administered exercises to be helpful with reducing pain; a study by Sousa et al. showed that by using the Tuina techniques, the orchestra musicians' pain was effectively reduced (2015). Although both of our studies included exercises for the musicians, Sousa's study had the musicians performing the Tuina exercises twice a day or more, whereas our study had the musicians completing the exercises twice a week. Sousa also conducted the study for a period of twenty days, and our intervention period was eight weeks, which could have made specific results different amongst the studies (Sousa et al., 2015). Completing the exercises more than twice a week and perhaps twice a day like Sousa's study could add potential benefits in terms of reducing pain. Lundborg et al.'s (2018) study with Resistance Training for Professional String Musicians also showed to have improvements in their mobility, and performance while playing, along with an increase in isometric endurance and strength in their neck, upper extremities, and back extensors. Lundborg et al. and our study had similar methods because both had exercise sessions twice a week, however Lundborg et al's study lasted eleven weeks compared to eight. Lundborg et al.'s study also focused more on isometric strength and

back endurance and less on stretching which may have made specific results different between the Lundborg et al. and our study.

When looking at pain levels in females versus males, females had a positive trend of more pain than the males when looking at the pre-exercise intervention questionnaire pain scales. This was not shown statistically significant; however, other studies have also seen reported problems higher in females than with males, due to joint laxity, hormonal differences, and smaller body frames (Ajidahun et al., 2017).

Within the results, cellos and violas were seen to have the most effected pain, especially in hand pain. This was different among other articles; in Ajidahun et al.'s (2017) study did not find any significant difference between musculoskeletal problems between upper strings (viola and violin) and lower string instruments (double bass and cello). However, Abréu-Ramos and Micheo (2007) found a higher prevalence in lower string players problems compared to upper string players when looking at a professional symphony orchestra. Although there are a wide variety of results found, Ajidahun et al. (2017) noticed that there may be an "influence of the weight of instruments on the distribution of the musculoskeletal problems" (p.6). This may be a beneficial aspect to investigate in future studies.

In the post-exercise intervention questionnaire survey, the participants were asked if they enjoyed the exercises, their self-evaluation of the importance of stretching, and if they were implementing more exercises and stretches on their own after they participated in the study. Based on the participants' answers, five out of the seven participants answered "somewhat, a lot, or extremely" for the enjoyment of the exercises. With the importance of the stretching, four out of the seven felt the exercise program was either important or very important. All seven participants answered that they would participate in an exercise program again, and six out of the

seven said they would implement exercises and stretches on their own after participating in the study.

Based on the results of our study and other studies relating, there are various directions that can be taken for future studies. One idea may be to increase the amount of exercises periods per week that was seen in Sousa et al.'s (2015) study. Another aspect to examine would be to understand the specific areas of pain musicians are experiencing and aim the exercises/stretches at those areas. Another route may be to have different exercise programs for females versus males, due to the studies showing females experiencing more pain than males (Ajidahun et al., 2017). Due to COVID-19, procedural changes did occur compared to the original design, specifically having all the meetings online. However, this information may be beneficial for future experimental procedures due to the positive results of the study being done remotely.

Limitations to the Study

Both the pre and post-exercise intervention questionnaire were self-administered and some bias could have occurred in these circumstances. This may include lack of honesty in their answers, their inability to assess themselves accurately, or the pain scales varying from person to person. In order to minimize these efforts, the questions and language in the pre and post questionnaires were short and concise, an interval scale was used, and the time frame was a relatively short period. The self-administered questionnaires were also seen in Ajidaun et al. (2017), in which his study had self-administered questionnaire which also relied on subjective opinions. Ajidahun et al. (2017) shared that in his study, musicians with a history of musculoskeletal problems may be more motivated than musicians without a history of musculoskeletal problems to respond to the survey, which may skew the reported prevalence.

Due to COVID-19, all meetings for the program had to be through Zoom instead of in-person, which could have caused confusion with regards to the instructions of the exercises; this could have skewed some of the results in the experimental group. This may be a general limitation for many researchers during this time. In order to minimize the confusion, exercise examples were given through the Zoom meetings, and the participants were able to ask questions about them during the meeting or via email throughout the exercise intervention program.

Conclusion

In this study, the major discovery was that musicians' pain in various areas can be reduced with the assistance of an isometric exercise and stretching program. The pain experienced by string musicians while playing either while self-practicing and small or large ensemble practice is a concern amongst college students. In the intervention program, isometric and stretching exercises were found to reduce pain in the head and neck area in self practice and back pain in large ensembles for string musicians. It is advisable to implement these stretches and exercises not only to decrease discomfort and pain, but also improve performances. In order for the musicians to grow in their playing and not be affected by pain, education and prevention programs should be put into place, along with a relationship between health practitioners and musicians. Based on the results of this study, other exercise programs should be administered to college musicians and have a larger sample size to determine what is the most beneficial action for this problem. Another step needed in this realm of research would also be to narrow down the risk factors causing these problems amongst musicians, then administer an exercise/stretching program specifically designed for certain instruments.

References

Abréu-Ramos, A. M., & Micheo, W. F. (2007). Lifetime prevalence of upper-body musculoskeletal problems in a professional-level symphony orchestra: Age, gender, and instrument-specific results. *Medical Problems of Performing Artists, 22*(3), 97-104. doi:10.21091/mppa.2007.3022

Ajidahun, A. (2013). Content of a warm up programme for instrumental musicians: A Delphi study. *Medicina Sportiva, 9*(2). doi:10.1163/1874-6772_seg_a63_368

Ajidahun, A. T., Mudzi, W., Wood, W., & Myezwa, H. (2017). Musculoskeletal problems among STRING instrumentalists in South Africa. *South African Journal of Physiotherapy, 73*(1). doi:10.4102/sajp.v73i1.327

Ajidahun, A. T., Myezwa, H., Mudzi, W., & Wood, W. (2019). A scoping review of exercise intervention for playing- related musculoskeletal disorders (prmds) among musicians. *Muziki, 16*(1), 7-30. doi:10.1080/18125980.2019.1606675

Chan, C., & Ackermann, B. (2014). Evidence-informed physical therapy management of performance-related musculoskeletal disorders in musicians. *Frontiers in Psychology, 5*. doi:10.3389/fpsyg.2014.00706

Foxman, I., & Burgel, B. J. (2006). Musician health and safety. *AAOHN Journal, 54*(7), 309 316. doi:10.1177/216507990605400703

Gasenzer, E., Klumpp, M., Pieper, D., & Neugebauer, E. (2017). The prevalence of chronic pain in orchestra musiciansGa. *GMS German Medical Science, 15*, 1-9.

Lee, H., Park, H. Y., Yoon, J. O., Kim, J. S., Chun, J. M., Aminata, I. W., . . . Jeon, I. (2013). Musicians' medicine: Musculoskeletal problems in string players. *Clinics in Orthopedic Surgery*, *5*(3), 155. doi:10.4055/cios.2013.5.3.155

Lundborg, B., & Grooten, W. J. (2018). Resistance training for professional string musicians: A prospective intervention study. *Medical Problems of Performing Artists*, *33*(2), 102 110. doi:10.21091/mppa.2018.2017

Marine Safety Education Association. (2015). *Pocket Guide to Ergonomics*. Sitka,Alaska: Alaska Marine Safety Education Association (AMSEA).

Nawrocka, A., Mynarski, W., Powerska, A., Grabara, M., Groffik, D., & Borek, Z. (2014). Health-oriented physical activity in prevention of musculoskeletal disorders among young Polish musicians. *International Journal of Occupational Medicine and Environmental Health*, *27*(1). doi:10.2478/s13382-014-0224-5

Online home exercise program - rehab - physical Therapy, occupational Therapy, physical therapist, Occupational THERAPIST, Therapeutic Exercises, HEP. (n.d.). Retrieved February 15, 2021, from https://www.hep2go.com/

Riebe, D. (2018). ACSM's Guidelines for Exercise Testing and Prescription. In 1197114184 894120496 Wolters Kluwer Health (Author), *ACSM's Guidelines for Exercise Testing and Prescription* (pp. 168-171). Philadelphia, PA: American College of Sports Medicine.

Sousa, C. M., Coimbra, D., Machado, J., & Greten, H. J. (2015). Effects of Self-administered exercises based ON Tuina techniques on musculoskeletal disorders of professional

ORCHESTRA MUSICIANS: A randomized controlled trial. *Journal of Integrative Medicine, 13*(5), 314-318. doi:10.1016/s20954964(15)60194-7

Tariq, M., Sarfraz, N., & Gilani, H. (2017). Comparative effects of pilates and isometric exercises on pain, functional disability and range of motion in patients with knee osteoarthritis. *Research Journal of Health Sciences, 5*(2), 94. doi:10.4314/rejhs.v5i2.5

Wilke, C., Priebus, J., Biallas, B., & Froböse, I. (2011). Motor activity as a way ofpreventing musculoskeletal problems in string musicians. *Medical Problems of Performing Artists, 26*(1), 24-29. doi:10.21091/mppa.2011.1003.

Appendix A.

Physical Activity Readiness Questionnaire - PAR-Q (revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
☐	☐	**1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?**
☐	☐	**2. Do you feel pain in your chest when you do physical activity?**
☐	☐	**3. In the past month, have you had chest pain when you were not doing physical activity?**
☐	☐	**4. Do you lose your balance because of dizziness or do you ever lose consciousness?**
☐	☐	**5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?**
☐	☐	**6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?**
☐	☐	**7. Do you know of any other reason why you should not do physical activity?**

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- if you are or may be pregnant – talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME _____

SIGNATURE _____ DATE _____

SIGNATURE OF PARENT or GUARDIAN (for participants under the age of majority) _____ WITNESS _____

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

Supported by: Health Canada Santé Canada

continued on other side...

Appendix B.

Exercise Log Book

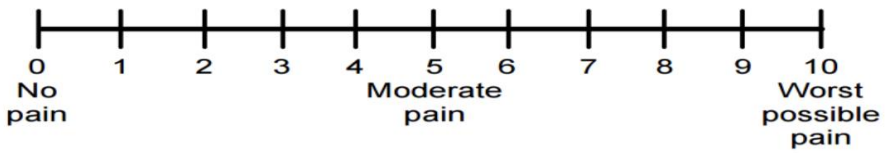
	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Tuesday Exercises Completed								
Thursday Exercises Completed								
Problems during the Stretches and/or Exercises								
Comments:								

Appendix C. Pre-Exercise Program Questionnaire

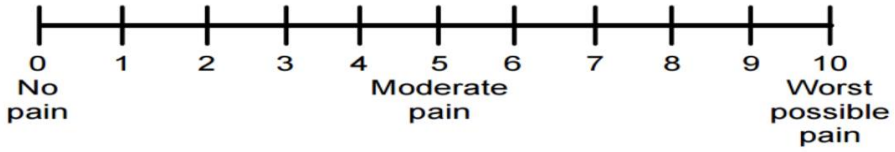
1. Exercise Program Participant Control Group Participant
2. Age:
3. Sex:
   Male Female Prefer not to say
4. Dominant Hand
   Left Right
5. Instrument:
   Violin Viola Cello Bass
6. Major or minor in music
   Major Minor
7. Undergraduate or Graduate Student
   Undergraduate Graduate
8. What music groups are you in? (Circle as many as applies)
   Self- Practice Small Group Ensemble Large Group Ensemble
9. On an average week, how much do you exercise?
   0 days 1-2 days 3-4 days 5+ days
10. How long have you been playing your instrument?
    0-4 years 5-8 years 9-12 years 13-16 years 17+ years
11. Approximately how many hours a week do you self-practice?
    1-5 hours 6-10 hours 11-15 hours 16-20 hours 21+hours
12. Approximately how many hours a week do you rehearse with ensembles?
    1-5 hours 6-10 hours 11-15 hours 16-20 hours 21+hours
13. On average, how many breaks do you take during self-practice?
    1 every 15 minutes
    1 every half hour
    1 every hour
    1 every two hours
    No breaks
14. On average, how many breaks do you take during rehearsal for small or large ensemble?
    1 every 15 minutes
    1 every half hour
    1 every hour
    1 every two hours
    No breaks

Pain experienced during Self Practice (if applicable; if you do not participate in Self-Practice, skip)

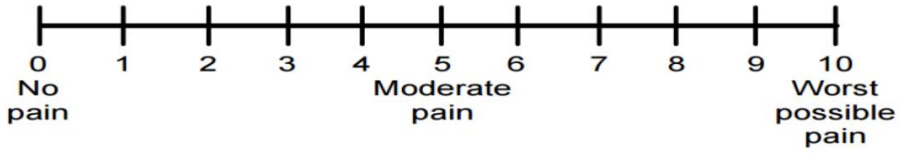
- **Head/Neck**



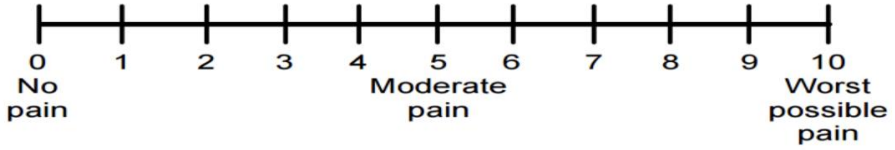
- **Shoulders L or R**



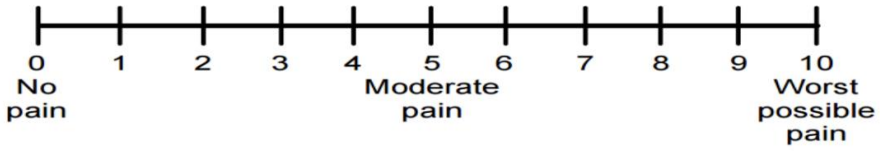
- **Back**



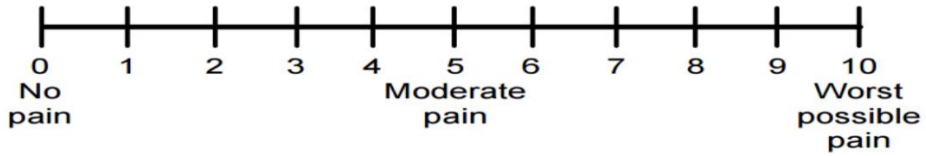
- **Elbow (L or R)**



- **Hand/Wrist (L or R)**



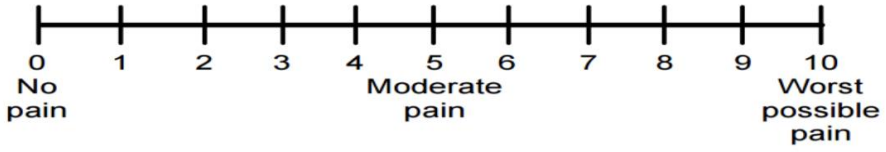
- **Lower extremities (hips, legs, ankles)**



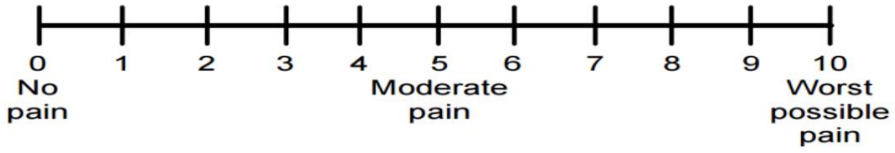
-

Pain Experienced during Small Group Ensemble (if applicable; if you do not participate in Small Group Ensemble, skip)

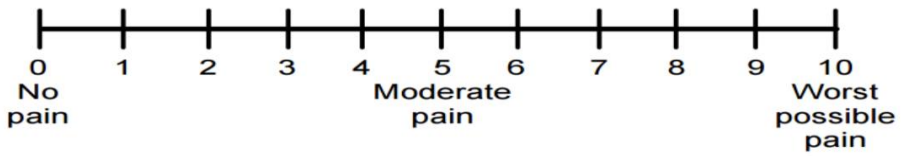
- **Head/Neck**



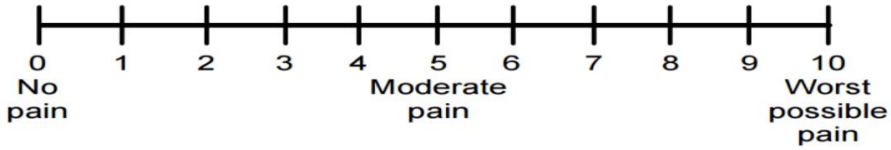
- **Shoulders L or R**



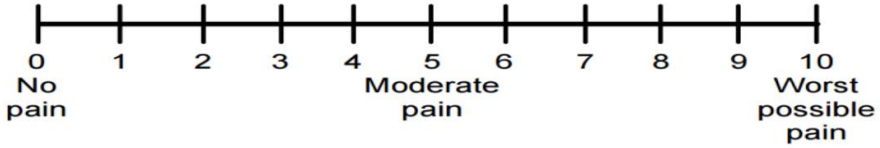
- **Back**



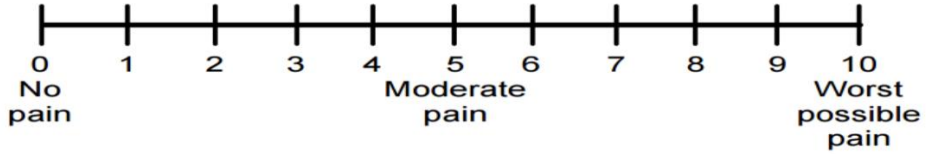
- **Elbow (L or R)**



- **Hand/Wrist (L or R)**

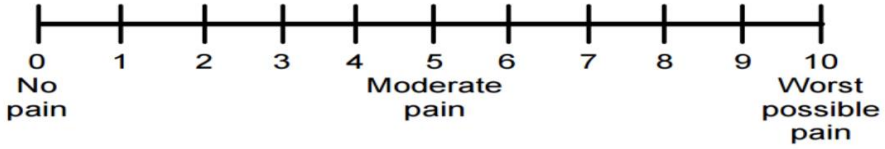


- **Lower extremities (hips, legs, ankles)**

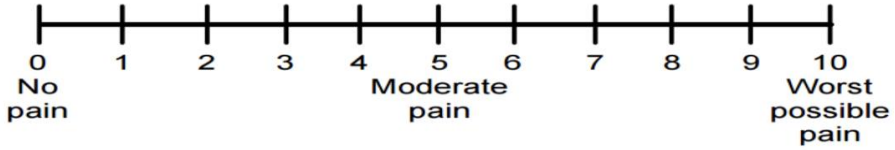


Pain Experienced during Large Group Ensemble (if applicable; if you do not participate in Large Group Ensemble, skip)

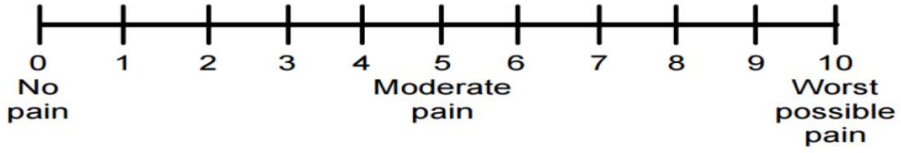
- **Head/Neck**



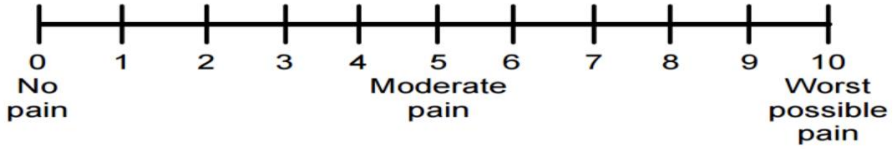
- **Shoulders L or R**



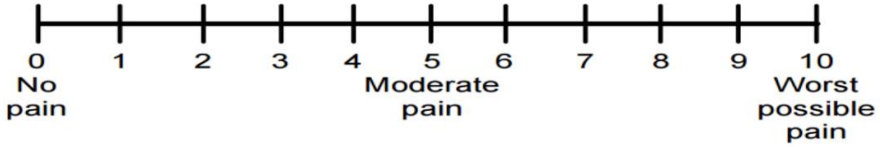
- **Back**



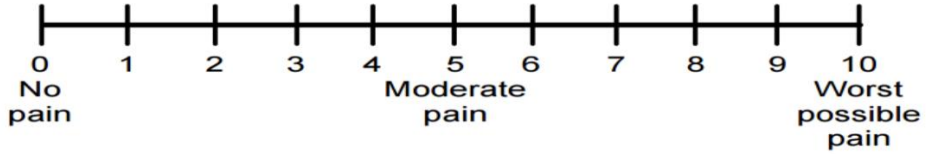
- **Elbow (L or R)**



- **Hand/Wrist (L or R)**



- **Lower extremities (hips, legs, ankles)**

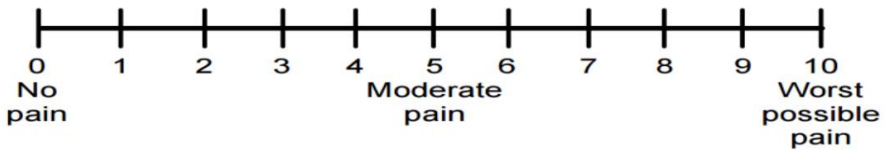


Appendix D. Post-Exercise Program Questionnaire

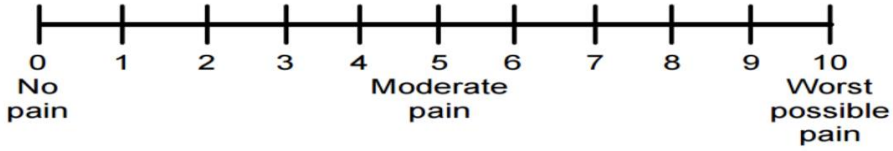
15. Exercise Program Participant Control Group Participant
16. Age:
17. Sex:
    Male Female Prefer not to say
18. Dominant Hand
    Left Right
19. Instrument:
    Violin Viola Cello Bass
20. Major or minor in music
    Major Minor
21. Undergraduate or Graduate Student
    Undergraduate Graduate
22. What music groups are you in? (Circle as many as applies)
    Self- Practice Small Group Ensemble Large Group Ensemble
23. On an average week, how much do you exercise?
    0 days 1-2 days 3-4 days 5+ days
24. How long have you been playing your instrument?
    0-4 years 5-8 years 9-12 years 13-16 years 17+ years
25. Approximately how many hours a week do you self-practice?
    1-5 hours 6-10 hours 11-15 hours 16-20 hours 21+hours
26. Approximately how many hours a week do you rehearse with ensembles?
    1-5 hours 6-10 hours 11-15 hours 16-20 hours 21+hours
27. On average, how many breaks do you take during self-practice?
    1 every 15 minutes
    1 every half hour
    1 every hour
    1 every two hours
    No breaks
28. On average, how many breaks do you take during rehearsal for small or large ensemble?
    1 every 15 minutes
    1 every half hour
    1 every hour
    1 every two hours
    No breaks

Pain experienced during Self Practice (if applicable; if you do not participate in Self-Practice, skip)

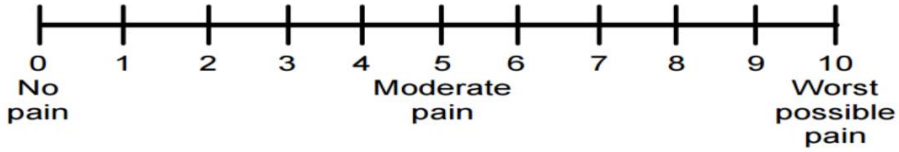
- **Head/Neck**



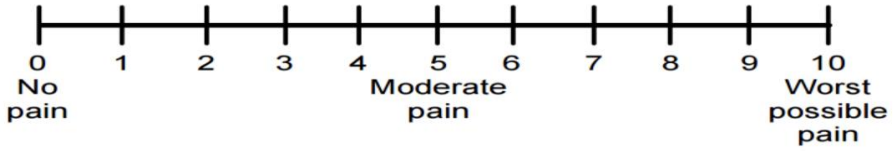
- **Shoulders L or R**



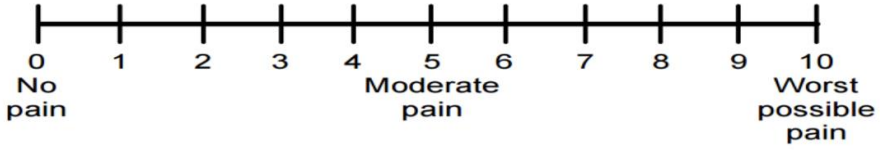
- **Back**



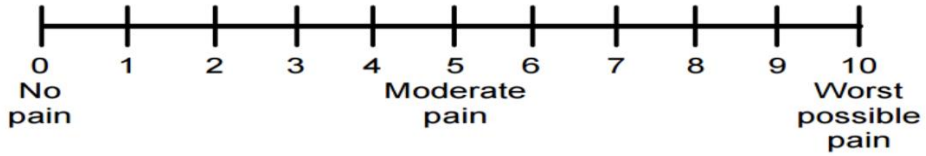
- **Elbow (L or R)**



- **Hand/Wrist (L or R)**



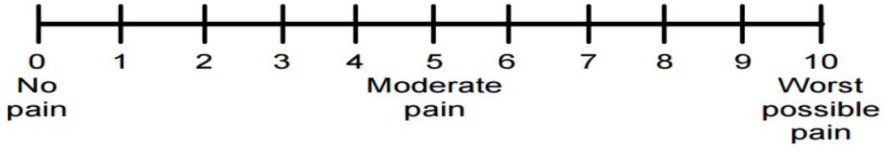
- **Lower extremities (hips, legs, ankles)**



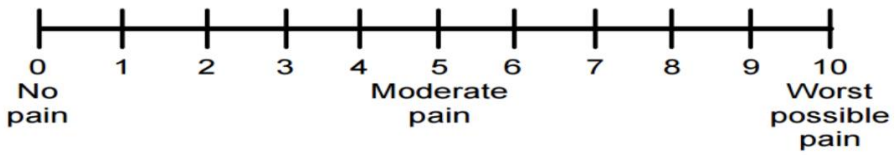
-

Pain Experienced during Small Group Ensemble (if applicable; if you do not participate in Small Group Ensemble, skip)

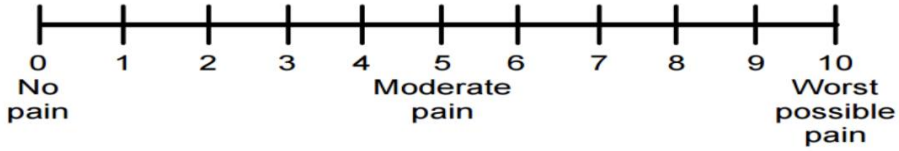
- **Head/Neck**



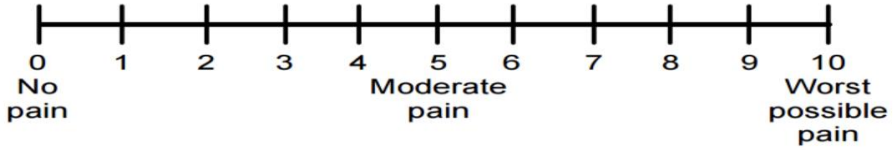
- **Shoulders L or R**



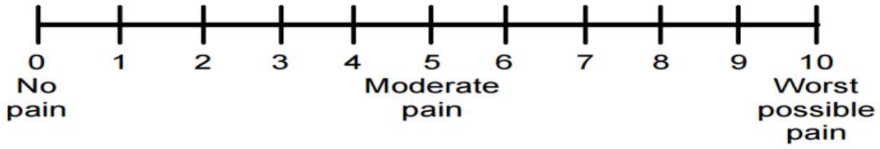
- **Back**



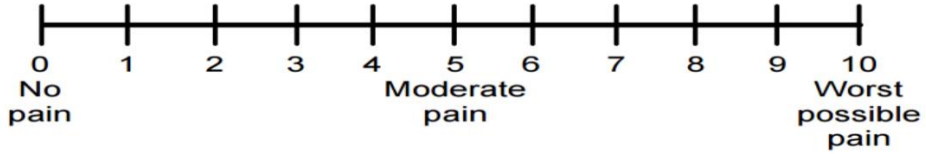
- **Elbow (L or R)**



- **Hand/Wrist (L or R)**

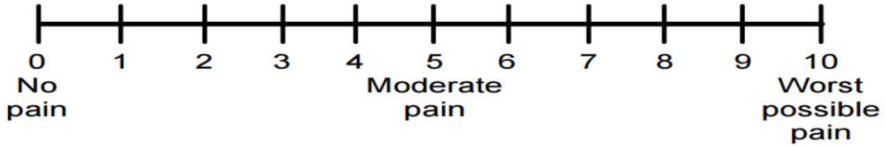


- **Lower extremities (hips, legs, ankles)**

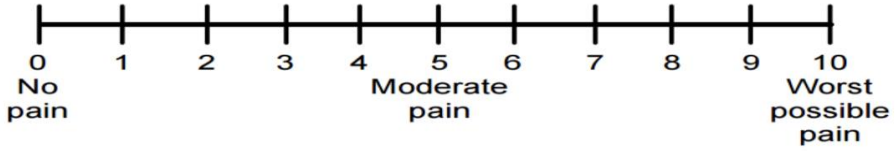


Pain Experienced during Large Group Ensemble (if applicable; if you do not participate in Large Group Ensemble, skip)

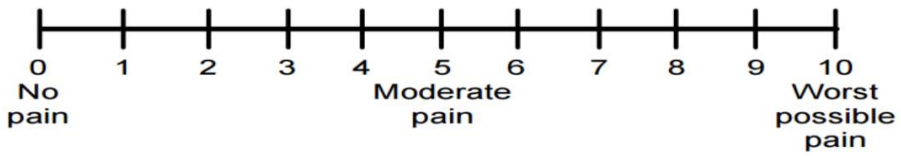
- **Head/Neck**



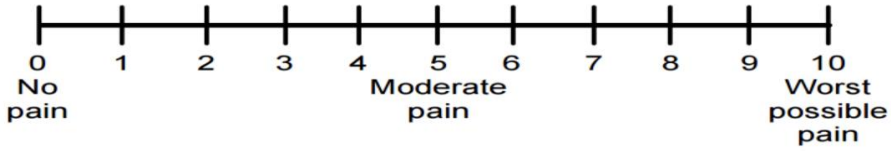
- **Shoulders L or R**



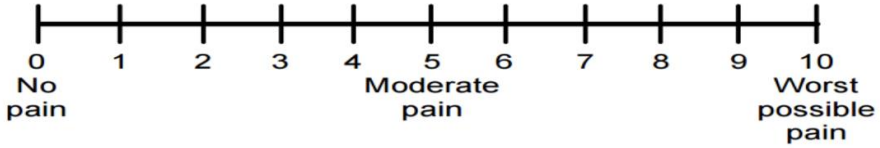
Back



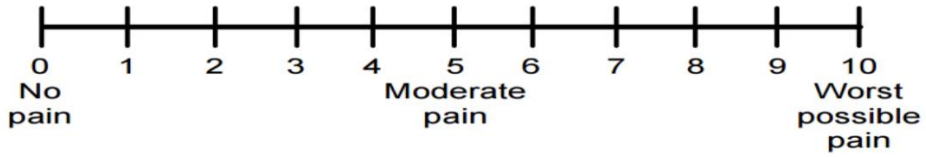
- **Elbow (L or R)**



- **Hand/Wrist (L or R)**



- **Lower extremities (hips, legs, ankles)**



If participated in the exercise program, please answer these questions:

1. How would you describe your stretches and exercises before you self-practice?
   Not important
   Somewhat important
   Important
   Very important
   Extremely important
2. Did you enjoy the stretches and exercises?
   Not at all
   A little bit
   Somewhat
   A lot
   Extremely
3. After participating in this study, would you implement your own stretches and exercises as a warmup for practicing?
   Yes No
4. Would you participate in this study again?
   Yes No
   a. If yes, would you change anything about it? Explain.